Perchance to Dream

Like sleep for a wretched few, a complete explanation of the mechanism of human consciousness still eludes us.

Mark Williams

LOOKING FOR SPINOZA
By Antonio Damasio, M.D., Ph.D.
Harcourt, 355 pages, $28

In the Veneto region of Italy, an aristocratic family is cursed with a macabre disease. This wealthy family is cultured, and its women are beautiful, but its members cannot easily find spouses and are routinely denied life insurance because many of them will die from a genetic disease called fatal familial insomnia, or FFI.

Once stricken, typically at about age 50, the FFI victim is suddenly unable to sleep. After being awake for weeks, the victim's pupils grow tiny, and blood pressure and pulse become permanently elevated. He or she sweats incessantly; the males become impotent. Victims lose the ability to balance and walk, though initially their consciousness remains intact. Victims may talk about their agony, as long as they are able to speak; after months of unrelenting wakefulness, sufferers are reduced to howling in terror. Still, even when a sufferer's exhausted system finally shuts down, the victim's desperate eyes show an awareness of what's happening. Only in the very last moments before death does the FFI patient lapse, mercifully, into a quasi-coma.

What does this loss of the ability to sleep—to suspend, at regular intervals, the onus of consciousness—tell science? To start with, if it weren't such a mundane recurrence, one might regard sleep as a terrible mystery. Yet as much as one-third of a person's existence is spent in this unproductive, highly vulnerable condition. As the sleep researcher Allan Rechtschaffen, Ph.D., has commented, "If sleep does not serve an absolutely vital function, it is the greatest mistake evolution ever made."[1]

The fate of FFI sufferers suggests two related conclusions. Firstly, if sleep—periodic nonconsciousness—is so essential, then its alternative—consciousness—is hardly likely to be just a hypothetical state. Secondly, if consciousness is indeed so demanding that an organism cannot sustain the condition without periodic rest, then sleep evolved to perform an absolutely vital function.

These are not minor assumptions. Twentieth-century science, unfortunately, possessed no tools to measure the reality of human consciousness. At least, it often acted as if it possessed none. The blame for this incuriosity does not lie with timid nonscientists who feared that science might explain away the human soul, but with the doctrines that scientists themselves subscribed to. During the first half of the 20th century, behaviorism was ascendant in American psychology. Aspiring to the status of hard science, psychology treated humans and other organisms as black boxes for which measurable stimuli must elicit measurable responses. The behaviorists refused to recognize subjective experience as a relevant explanation for human behavior. Consequently, this dogma colored many theorists' outlooks about the mind. Furthermore, by the time psychologists jettisoned behaviorism's crudely mechanistic stimulus-response model later in the 20th century, similar evasions of the problem of human consciousness were accommodated by the rise of computer science.

Hence, when asked whether machines could think, trailblazing cyberneticist Claude Shannon, Ph.D., replied: "You bet. We're machines and we think, don't we?" This was a fair statement for some-

one who believed—as Shannon did—that consciousness is a wholly mechanical property of matter and emerged only in certain very complex systems like human beings and their evolutionary relatives. Among many of the cybernetics-influenced theorists, though, such logic played out as an acceptance of the Turing test (devised by the British computer pioneer Alan Turing, who proposed that a computer in a box could be judged intelligent if its responses convinced a human being that he or she was communicating with another human) as a standard for judging human-equivalent intelligence in a machine, and vice versa. Thereafter, as a legion of dialogue programs like ELIZA, which was created in 1966, carried on quasi-plausible conversations with human interlocutors, it became apparent that rating a machine's intelligence on the basis of human gullibility might be as unintelligent as you could get. Never mind: the paradigm of the brain as a mere computer—as just another machine in a black box—was in place. Consciousness, with its socioreligious baggage and tortuous problems, could be dismissed glibly by mind theorists adhering to the computer model of mind as just a "user illusion," to use Danish writer Tor Norretranders's phrase.

All this has been unfortunate. If the only dependable means of assessing the reality of consciousness had been through personal revelation—René Descartes's famous *cogito ergo sum*—this would still constitute direct knowledge and could reasonably take priority over all other forms of insight, which, by comparison, are second-hand. If scientific observation then failed to confirm consciousness's existence—well, so much the worse for science. But, in fact, there are scientific observations attesting to it. One such pragmatic observation—a stark one—is cited above: what happens to victims of FFI, who cannot turn off their consciousness? Another pragmatic observation is that science can quantify consciousness. Or, at least, it was found—once a group of psychologists calling themselves the "Third Force" emerged in the late '50s and a few researchers began accepting that consciousness was a valid object of scientific investigation—that it's possible to quantify the total data rates inherent to the human brain, then compare them to the data-carrying capacity of conscious attention.

The results are illuminating. Vision is the most capacious sensory channel in humans: each eye transmits approximately 100 million bits of data per second into the occipital lobe. The largest organ, the skin, sends 10 million bits of tactile data per second to the sensory cortex. On the output side, speech is the most ample channel, capable of transmitting on the order of 10,000 bits per second. This may seem like a lot of data for the brain to handle, but it has capacity to spare: assuming that the firing of each neural synapse equals 1 bit of data, with 100 billion synapses capable of firing at a maximum rate of 100 times per second, the human cerebral cortex can handle about 10 trillion bits of data per second.

To quantify how much of all this neural processing translates into consciousness at any single moment, researchers have used screened displays that flash changing arrays of visual information before human subjects. Based on such experiments, the conscious data rate in human beings appears to be somewhere between 15 and 50 bits per second. Thus, consciousness represents much less than 1 part per 100 billion of the brain's processing capacity, almost as though the minuscule conscious "self" is inversely proportional to the vast power of the human brain.

As Antonio Damasio, M.D., Ph.D., the Van Allen distinguished professor and head of the University of Iowa Medical Center's neurology department, writes in his new book, *Looking for Spinoza: Joy, Sorrow and the Feeling Brain*: "Consciousness and mind are not synonymous. In the strict sense, consciousness is the process whereby a mind is imbued with a reference we call self, and is said to know of its own existence and of the existence of objects around it." After centuries of merely poking and slicing at a fist-size, 3-pound ball of cooling gray meat, hospitals and clinics now have batteries of scanning and imaging technologies that give neuroscientists pictures of how specific modules in the brain light up with increased activity as they work. Although scientists have hitherto postponed confronting the subject, these pictures are accumulating into an increasingly coherent representation of how the mind, as a whole, arises. Hence, while most people may still subscribe to some variation of Cartesian mind-body dualism—where the soul or the mind is conceived of as a "ghost in

the machine" coming down from outside to animate matter—scientists like Dr. Damasio are beginning to explain the neurobiology of feelings.

Consider the caress of somebody you desire. The color turquoise. The roar of a high wind. The sight of a dead family member's features as he lies in the funeral casket. What could be harder to substantiate than that such intense sensory experiences, with all the ineluctable emotions and feelings they carry, are delivered by specific, scientifically comprehensible processes?

These apparently intangible experiences are called qualia. They have been the central human mysteries, inexplicable under the old mind-body duality. If science could understand their underlying neurobiology, as it now understands, say, the neurobiology of vision, it would probably discover how emotions and feelings drive decision making and how they construct the self. People would likely gain an understanding of a large chunk of what constitutes mind and consciousness.

As it turns out, people *do* possess some of that knowledge. Dr. Damasio, for instance, recounts what he and other neuroscientists have learned about human emotion and feeling. He uses the story of the philosopher Baruch Spinoza as a scaffold on which to hang his account of the neurobiology of feelings. Spinoza rejected Cartesian dualism and, more interestingly, proposed that the human mind amounted to an "idea" that arose from the human body and represented its *conatus*—a Latin word meaning striving, endeavor, or tendency. Specifically, Spinoza argued, "the striving by which each thing strives to persevere in its being is nothing but the actual essence of the thing." Because sensory experiences would have developed their accompaniment of emotions and feelings only for an evolutionary benefit, presumably this accompaniment constitutes part of Spinoza's "striving to persevere."

While emotions and feelings seem so mixed as to constitute a single, continuous condition, Dr. Damasio writes in *Looking for Spinoza* that the evidence strongly suggests that is not the case. Instead, he argues, a sensory experience automatically triggers a physiological reaction people call an emotion, and that the conscious mind's recognition of that emotion is a feeling. Dr. Damasio, quoting Spinoza (whom he believes intuited this), says that emotion is the mind's "idea of the body."

In one simple, but telling, experiment, the prominent researcher Paul Ekman, Ph.D., asked his test subjects to move certain muscles of their faces in certain sequences until, unbeknownst to those subjects, their features were configured into expressions of joy, sadness, or fear. Suddenly, the subjects began, to a greater or lesser degree, to experience feelings matching the expressions they wore. In short, if the physical components of an emotion were assembled, the specific mental feelings accompanying that emotion were subsequently generated.

In another case, a 65-year-old woman with Parkinson's disease underwent a treatment in which tiny electrodes were implanted in her brain. Such electrodes, passing low-intensity, high-frequency currents, modify how motor nuclei in the brains of Parkinson's patients work; the disease symptoms often vanish, and patients' capabilities for movement may be restored. The mild electric current from one misplaced electrode abruptly produced bodily manifestations of acute depression—downturned mouth corners in a caricature of grief, for instance—which were subsequently followed by the woman's verbal communication of despairing feelings and ideas. When the doctor realized what was happening and turned the current off, the patient's embodied emotions and her inner experience of despair ceased as suddenly as they had began.

In brief, in both these cases, as Dr. Damasio points out, emotion preceded feeling and played out firstly in the body as facial, vocal, or visible behavior. Feelings, following those initial emotions, played out in the subject's consciousness and remained hidden unless intentionally communicated. Feelings, then, were dictated by emotions, which themselves were constituted from multiple volleys of neural and chemical responses that temporarily modified the organism's internal milieu, viscera, and musculoskeletal system. Thence, overt behaviors—facial expressions, vocalizations, body postures, and specific behaviors—were enacted.

In Dr. Damasio's view, feelings are the story the higher nervous system tells in response to emotions. In turn, people's emotions are basically products of their

inner worlds since they are mappings of either inner body states that arise as a reaction to external stimuli—for instance, triggers to sexual appetite—or those internal body states that are simply normal autonomic processes. The emerging picture that Dr. Damasio paints is of a multitiered neural mechanism that, having evolved for the regulation of the organism's processes, resembles a large branched tree. In this tree's uppermost branches are feelings. Below these emotions—things like joy, sorrow, fear, pride, shame, and sympathy—represent, as Dr. Damasio puts it, the "crown jewels" of automated life-regulation. Next down are drives and motivations—the specific appetites, like hunger and curiosity. Then, in the neural tree's midlevel branches, are behaviors associated with pleasure/reward and pain/punishment. Finally, in the lowest branches are the most basic mechanisms enabling the organism's homeostasis: things like the startle reflex, immune system behaviors, and purely chemical and mechanical transactions that maintain the organism's necessary internal balances.

Dr. Damasio has evidence for all this. Recently, he reports, his researchers used positive-emission tomography (PET) to measure increased blood flows in specific brain regions of subjects who were asked to recall emotionally potent episodes that would trigger joy, sadness, fear, or anger. Not only did heightened activity in specific brain regions correlate with specific emotions, but also some of the regions—for instance, the somatosensory cortices—were known to be responsible for mapping the body's ongoing condition. "The mind exists for the body, is engaged in telling the story of the body's multifarious events, and uses that story to optimize the life of the organism," he writes.

Still, while the mind is built from ideas that are, in one way or another, representations of the body, the brain does not begin as a blank slate. Rather, Dr. Damasio says, it comes programmed with extensive behaviors to manage the organism and certain kinds of external events. *Looking for Spinoza* doesn't dwell on how much of social behavior may be determined by epigenetic rules, which are the inherited propensities of people to invent, transmit, and receive certain cultural elements in preference to others. In particular, Dr. Damasio writes that he does not favor the attempt by some researchers to neurologize religious experiences.

Some biologists theorize that religious behavior derives from the simian propensity among human beings to create dominance hierarchies; thence, the symbol-forming human mind—"never satisfied with raw apish feeling," as Harvard University biologist Edward O. Wilson, Ph.D., puts it—extends these primate hierarchies into the realm of abstraction. By Dr. Wilson's account, deities amount to "hyperdominant if invisible members of the human group." By this neurobiological assessment of religion, advocates of monotheism who reckon it as religion's most advanced form are correct. The ultimate refinement of abstract primate dominance hierarchies would be a doctrine that envisions one indivisible god reigning over the universe: in the assessment of biologists, a great Sky Ape.

No wonder Dr. Damasio prefers to sidestep the whole subject. He's treading on difficult ground by proposing a materialistic explanation of the conscious mind. Consciousness, Dr. Damasio proposes, affords an integration of sensory phenomena across various modalities like vision and hearing. It permits images and ideas from memory to be integrated alongside immediate sensory impressions. Finally, these integrations of richly disparate types of mental activities and information provide vast options for problem solving and creative connectivity.

While Dr. Damasio has provided some answers about how emotions and feelings combine to create the conscious mind, he has not offered a good theory of the underlying physical mechanisms that would span that continuum between one's individual neurons and one's sense of self.

So, have neuroscientists arrived at satisfactory explanations of consciousness that do span that continuum? They have made a beginning. The growing knowledge of how genes are expressed in specific brain regions and how these regions coöperate to create the mind will engender biomedical applications that could profoundly transform some individual lives and, in some cases, challenge society's notions about what is human.

[1] Max, D.T. (May 6, 2001) Case study: fatal familial insomnia; location: Venice, Italy; To Sleep No More. *The New York Times Magazine*.